Observations on the Reproductive Biology of the Kellet's Whelk, *Kelletia kelletii*

(Gastropoda : Neptuneidae)

BY

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(Plates 48 and 49; 4 Text figures)

INTRODUCTION

The Kellet's Whelk, *Kelletia kelletii* (Forbes, 1850) (Plate 48) has been reported along the eastern Pacific Ocean from Santa Barbara, California, to San Quentin Bay, Baja California (Abbott, 1954, p. 231). *Kelletia kelletii* is commonly found off southern California in kelp beds and on nearshore reefs. Its vertical distribution is typically subtidal, extending from 2 to about 70 m in depth.

Kelletia kelletii has a relatively large spindle-shaped dextrally spiralled shell. It is one of the larger gastropods found in southern California waters. During this study the largest individual had a shell length of 148 mm. Although *K. kelletii* is one of the more abundant species of the Neptuneidae found in southern California, it has not been studied extensively and the literature contains only brief discussions on the biology of this gastropod (MacGinitie, 1949; Limbaugh, 1955).

This paper is concerned with the reproductive biology of *Kelletia kelletii*. Observations were made during 1968 and 1969 both in the experimental tanks of the U. S. Bureau of Commercial Fisheries at La Jolla, California and while diving on nearshore reefs off San Diego County.

MATING BEHAVIOR

The sexes are separate in *Kelletia kelletii,* and mature males can be identified by the presence of a penis located in the head region back of the right tentacle within the mantle cavity. During the reproductive season the mature testis is usually reddish-brown, and the mature ovary is yellow-orange. Paired individuals have been sighted as early as January during 1968 and 1969. Fertilization is internal and the copulatory act was observed frequently during March, April and May of both years. During copulation, the male grasps the female's shell with his foot and the outer lips of both shells are usually brought close together. The male then extends his penis over the outer lip of the female's shell between the foot and the mantle cavity (Plate 49).

Mating appears to be somewhat size-selective, since the female was generally the larger member of the copulating pair (Text figure 1). The female had a mean shell length 13 mm larger than the male partner in the 124 copulating pairs observed. The shell lengths in these mating pairs ranged between 62 - 120 mm for the males and between 71 - 121 mm for the females. Sexually active males greater than 80 mm in shell length were available to the spawning population; yet in only 11 out of the 124 copulating pairs was the male larger than the female. The shell length (siphonal canal to the apex) was determined by measuring each individual to the nearest mm with plastic calipers either underwater or in the laboratory.

Males seem to attain sexual maturity at a smaller size (earlier age) than do the females. Whether this is the result of sexual differences in growth rate or due to a delay in spawning by females until larger size is obtained has not yet been determined. Pearce & Thorson (1967) believe that female *Neptunea antigua* (Linnaeus, 1758) postpone spawning until they have attained full size, and that males become sexually active at a smaller shell size than females. Sexual dimorphism in prosobranch mollusks has been observed in various species with the female generally larger than the male (Hyman, 1967). Edwards (1968) observed, however, that male *Olivella biplicata* (Sowerby, 1825) were significantly larger and grow more rapidly than the females.

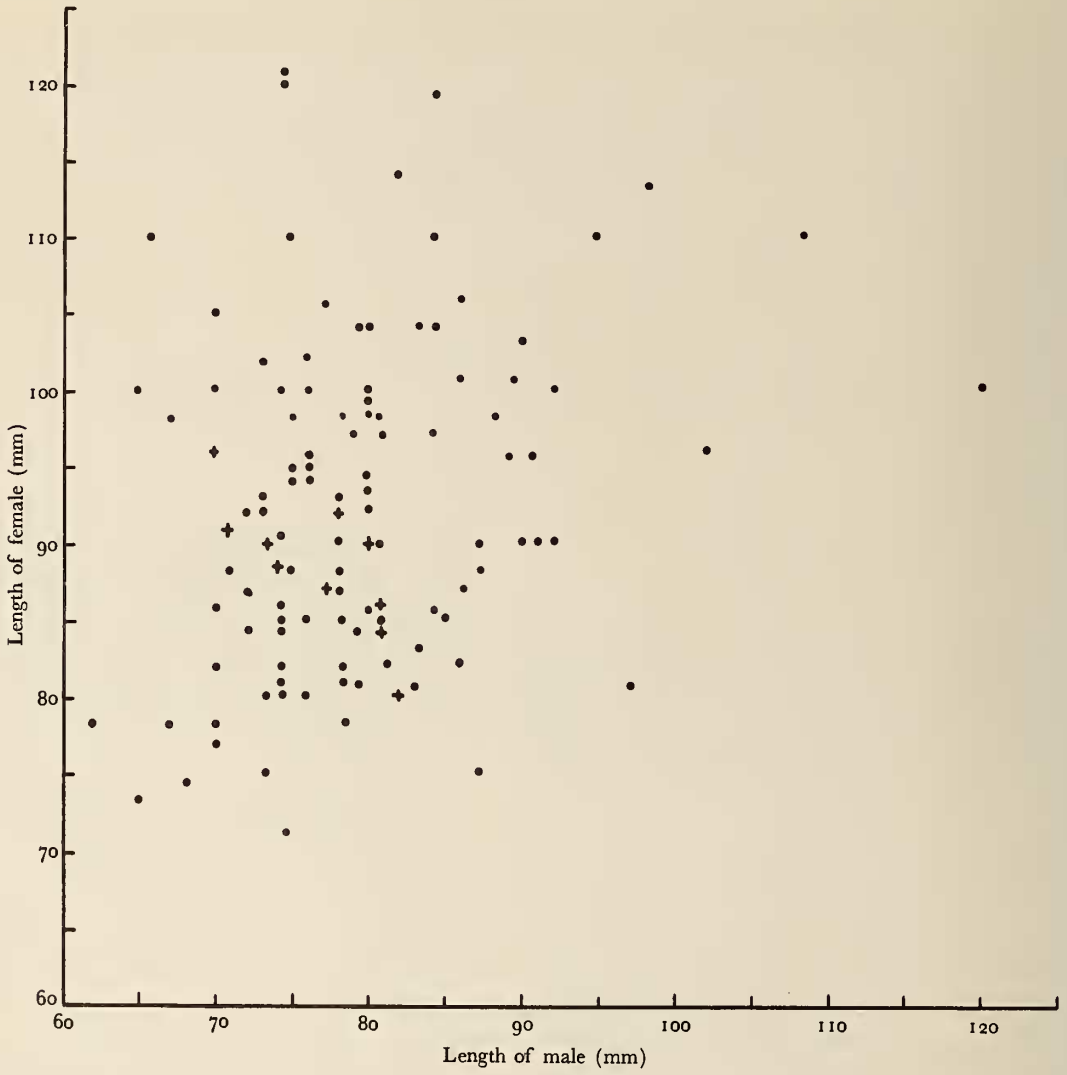

Figure 1

A comparison between the lengths of females and males in 124 copulating pairs. These pairs were measured underwater (in depths of from 18 m to 25 m) between 11 April and 16 May, 1969. Four locations off San Diego county were investigated: Point Loma (32°43′ N Lat.); Bird Rock (32°49′ N Lat.); Point La Jolla (32°51′30″ N Lat.); and Del Mar (32°57′ N Lat.).

· = 1 pair

+ = 2 pairs

The size differential in a mating pair may be of benefit to the female *Kelletia kelletii,* since she has the ability to move around more easily with a smaller size male attached to her shell during mating or egg deposition or both. Distinguishing sexes in the field is usually relatively easy since the anterior ends of both members are generally pointed in the same direction, with the male on the right side or on top of the larger female.

Copulation has been observed prior to and during oviposition. One female (102 mm) was observed in the laboratory to copulate 6 times with 5 different male partners over a 30-day period. In each instance, egg laying either followed or took place simultaneously during copulation.

A spawning female *Kelletia kelletii* 20 m underwater

SPAWNING BEHAVIOR

Spawning commenced during April both in the laboratory and in the subtidal areas examined during 1968 and 1969. The water temperatures at 20 - 25 m for April 1969 in the vicinity of La Jolla, California ranged from approximately 10.5° C to 13.8° C, compared to 14.5° C to 16.9° C in the experimental tanks at the U. S. Bureau of Commercial Fisheries Laboratory.

Orton (1920) pointed out that the temperature generally controls the process of gonadal ripening in marine invertebrates, and that to spawn most invertebrates seem to require much higher temperatures than are necessary at other periods. The data collected on *Kelletia kelletii* suggest that factors other than just temperature are involved in the inducement of spawning. Oviposition in the laboratory has coincided with spawning in subtidal regions even though it occurred on the same day at significantly different water temperatures – such as 10.5° C at a depth of 20 m off Point Loma, California, compared to 16.5° C in the laboratory water table.

Five spawning females which were tagged underwater (Rosenthal, 1969) in April 1968 were located in April or May of the following year and found to be either copulating or depositing egg capsules for the second year in a row. It is believed that spawning takes place annually in mature females (> 70 mm), and that the greatest reproductive success is reached when the female is between 80 - 90 mm in shell length (Text figure 2).

The females deposit their egg capsules on almost any available hard substrate such as rocks, discarded mollusk shells, or even on the shells of living *Kelletia kelletii*. Oviposition in the aquaria generally was confined to the vertical sides of the tanks. In subtidal regions the animals usually favor low relief rocky substrates which are relatively free of sessile macro-organisms. Egg-laying females have not been observed depositing capsules on substrates occupied by large numbers of sea urchins.

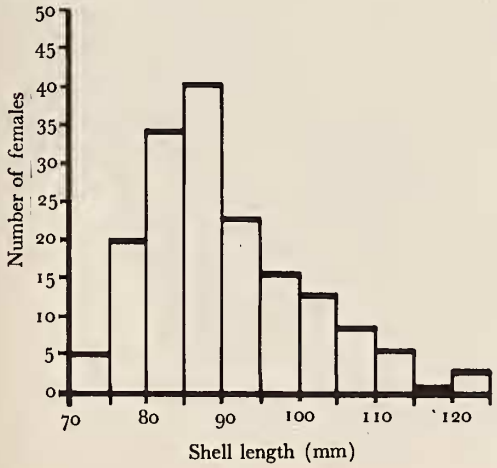

Figure 2

The shell lengths of egg laying females. A total of 170 ovipositing individuals were measured between 11 April and 16 May, 1969

During the height of the egg-laying period (April to May) extensive aggregations of both male and female *Kelletia kelletii* have been seen repeatedly in a kelp bed off Del Mar, California. On 30 April 1968, between 200 and 300 individuals were observed in a spawning aggregation contained within a 20 m^2 area at a depth of 19 m. Aggregations of 15 to 20 individuals are quite common within this kelp bed during the spawning season.

Aggregations of spawning gastropods have been observed in *Strombus gigas* Linnaeus, 1758 by D'Asaro (1965), and in *Urosalpinx cinerea* (Say, 1822) by Carriker (1955). It has been indicated by Pearce & Thorson (1967) that adult *Neptunea antigua* aggregate during the spawning season. *Kelletia kelletii* is generally found in an aggregated distribution pattern throughout the year, but large numbered groups have been observed only during communal feeding and spawning activities. It is felt that mass aggregations of *K. kelletii* during the spawning season may be the result of chemoreceptive detection of the egg capsules or mucous trails of sexually active snails.

Spawned egg capsules may act as additional stimuli to other mature females which encounter these capsules. Spawning females seem to favor ovipositing on substrates which already contain *K. kelletii* egg capsules. Spawning inducement of this sort was observed by D'Asaro (1966) in the gastropod *Thais haemastoma floridana* Conrad, 1837. Aside from chemoreception, the egg depositing stimulus may be influenced by tactile responses in the foot and head region of mature females encountering egg capsules on the substrate. It seems likely that a series of factors, such as gonadal ripeness, fluctuating temperatures, proper substrate, and the presence of other spawning females may trigger egg deposition in *K. kelletii*.

In the laboratory a female *Kelletia kelletii* (104 mm) was known to spawn on 4 different occasions over a period of 30 days, depositing a total of 85 egg capsules during this period. Another spawning female (78 mm) laid 22 capsules over a 24-hour period for a mean per hour rate of 0.92 capsules. If the female was disturbed in the aquarium while egg laying, the spawning act might halt and be resumed again at some later time. In subtidal areas tagged female *K. kelletii* have been observed depositing egg clusters one day, and on subsequent days these same individuals were found laying additional egg capsules in new locations. Carriker (1955) observed that spawning *Urosalpinx cinerea* females did not always deposit their

egg capsules at one time, but may lay a number of egg clutches throughout the spawning season. Following oviposition, the *K. kelletii* move away from their egg capsules and there is no attempt to guard or brood these capsules.

EGG CAPSULES, EGGS, AND DEVELOPMENT

The egg capsule, or ootheca, is the protective enclosure housing the eggs during the developmental period up to the time of hatching. The ventral pedal gland in the middle of the foot manipulates and hardens the capsule into a definite shape, and secretions are added to cement each capsule firmly to the substrate by an adhesive gelatinous base. Formation and secretion of the stenoglossan egg capsule has been extensively reviewed by FRETTER (1941).

The egg capsules are ovoid and somewhat deflated in shape, one face of the capsule is slightly convex (Plates 48, 49). When first deposited they appear translucent white but darken with the passage of time due to the development and pigmentation of the larvae within the egg capsules. The capsules are attached to the substrate by one end and are usually deposited in groups or clusters, seemingly without any definite pattern or order. The free end of the capsule is closed with a proteinaceous plug that weakens and dissolves as the embryos reach the hatching stage.

The height of the egg capsule is dependent upon the size of the spawning female *Kelletia kelletii*. During laboratory observations a female 78 mm in shell length deposited egg capsules with a mean height of 7.5 mm compared to a 120 mm female which laid capsules 12.3 mm in height. Individual egg capsules obtained from different females contained between 400 and 1 022 eggs, although occasionally a few egg capsules in a cluster are empty. MACGINITIE (1949) reported counting 2 182 eggs in one *K. kelletii* capsule.

The newly spawned eggs are yellow in color, each one between 200μ and 300μ in diameter. The egg undergoes a typical spiral determinate cleavage pattern with the

Figure 3

Trochophore stage of *Kelletia kelletii* after 13 days in the egg capsule